

WHAT IS CLAIMED IS:

1. A method for storage of molecular gas, comprising:
  - 5 forming an aerogel structure;
  - forming fibers inter-engaged in said aerogel structure; and
  - sorbing a molecular gas into said aerogel structure and said fibers.
2. The method of Claim 1, wherein said molecular gas is taken from the group
  - 10 consisting of hydrogen and oxygen.
3. The method of Claim 1, wherein said inter-engaged fibers are randomly disposed in said aerogel structure.
- 15 4. The method of Claim 1, wherein said aerogel structure comprises a catalyzed carbon aerogel catalyzed monolith structure.
5. The method of Claim 1, wherein said fibers comprise solid fibers or hollow tubes.
- 20 6. The method of Claim 1, wherein said forming of said aerogel structure comprises heating said aerogel structure to cause the formation of pores.
7. The method of Claim 6, wherein said pore sizes range up to about 1000
  - 25 Angstroms.
8. The method of Claim 1, wherein said forming of said fibers comprises depositing of a metal catalyst on said aerogel structure to allow bonding of said metal catalysts to carboxyl sites disposed on said aerogel structure to form catalyst islands.
- 30 9. The method of Claim 8, wherein said deposited metal catalyst is taken from a group of transition metals consisting of Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn and combinations thereof.

10. The method of Claim 8, wherein said deposited metal catalyst is comprised of 70% Fe and 30% Cu.
11. The method of Claim 8, wherein said depositing of a metal catalyst on said 5 aerogel structure occurs at a temperature in the range of between about 500 °F and about 2000 °F.
12. The method of Claim 1, wherein said sorbing a molecular gas into said aerogel structure and said fibers comprises exposing said molecular gas maintained at a 10 temperature between about 77K and about 300K to said aerogel structure and said fibers.
13. A method for storage of molecular gas, comprising:  
forming a polymeric structure of interconnected particles creating open cells;  
depositing a catalyst on said polymeric structure to form catalyst islands;  
15 growing nanostructures from said catalyst islands; and  
sorbing a molecular gas into said polymeric structure and said nanostructures.
14. The method of Claim 13, wherein said forming a polymeric structure of interconnected particles creating open cells comprises preparing a solution of one of 20 either formaldehyde-resorcinol (RF) and phenolic-furfural (PF).
15. The method of Claim 13, wherein said forming a polymeric structure of interconnected particles creating open cells comprises forming a carbon aerogel structure having a density of about the order of 100 mg/cc.  
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16. The method of Claim 13, wherein said forming a polymeric structure of interconnected particles creating open cells comprises forming a carbon aerogel structure having a surface area in the range of between about 0.2 m<sup>2</sup>/gm and 3000 m<sup>2</sup>/gm.
- 30 17. The method of Claim 13, wherein said depositing a catalyst on said polymeric structure to form catalyst islands comprises depositing a metal catalyst on said polymeric structure to allow bonding of said metal catalysts to carboxyl sites disposed on said polymeric structure to form said catalyst islands.

18. The method of Claim 13, wherein said deposited metal catalyst is taken from a group of transition metals consisting of Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn and combinations thereof.

5 19. The method of Claim 13, wherein said deposited metal catalyst comprises an alloy of 70% Fe and 30% Cu.

20. The method of Claim 13, wherein said molecular gas is taken from the group consisting of hydrogen and oxygen.

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21. The method of Claim 13, wherein said polymeric structure is taken from the group consisting of a catalyzed carbon aerogel monolith structures, metal oxide aerogels, ceramic aerogels, silica aerogels, and zeolites.

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22. The method of Claim 13, wherein said nanostructures comprise solid fibers or hollow tubes of carbon.

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23. The method of Claim 13, wherein said forming a polymeric structure of interconnected particles creating open cells comprises heating said polymeric structure to control the formation of said open cells.

24. The method of Claim 23, wherein said open cells range in size up to about 1000 Angstroms.

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25. The method of Claim 13, wherein said growing nanostructures from said catalyst islands comprises preparing graphite nano-filaments by the decomposition of an effective amount of carbon-containing gas mixture precursors on said polymeric structure at an elevated temperature.

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26. The method of Claim 25, wherein said elevated temperature is in the range of between about 500 °F and about 2000 °F.

27. The method of Claim 25, wherein said carbon- containing gas mixture comprises gases taken from the group consisting of acetylene, benzene, carbon dioxide, carbon monoxide, hydrogen, and methane.

5 28. The method of Claim 13, wherein said nanostructure comprises a structure taken form the group consisting of platelet carbon nano-fiber, cylindrical carbon nanostructure, ribbon carbon nano-fiber, faceted tubular carbon nano-fiber and herringbone carbon nano-fiber.

10 29. The method of Claim 13, wherein said nanostructures are randomly disposed in said polymeric structure.

15 30. The method of Claim 13, wherein said sorbing a molecular gas into said polymeric structure and said nanostructures comprises exposing said molecular gas maintained at a temperature between about 77K and about 300K to said polymeric structure and said nanostructures; and thereafter allowing said temperature to increase to an ambient temperature.

20 31. A gas storage apparatus comprising:  
a pressure vessel including:  
a polymeric structure of interconnected particles creating open cells; and  
a nanostructure grown on said polymeric structure, said polymeric structure and said nanostructure capable of sorbing a molecular gas.

25 32. The apparatus of Claim 31, wherein said nanostructure comprise a structure taken form the group consisting of platelet carbon nano-fiber, cylindrical carbon nanostructure, ribbon carbon nano-fiber, faceted tubular carbon nano-fiber and herringbone carbon nano-fiber.

30 33. The apparatus of Claim 31, wherein said interconnected particles comprise particles having a diameter of up to the order of 100 Angstroms.

34. The apparatus of Claim 31, wherein said polymeric structure of interconnected particles creating open cells comprises a polymeric structure formed from a solution of one of either formaldehyde-resorcinol (RF) or phenolic-furfural (PF).

5 35. The apparatus of Claim 31, wherein said polymeric structure of interconnected particles creating open cells comprises a carbon aerogel structure having a density of about the order of 100 mg/cc.

10 36. The apparatus of Claim 31, wherein said polymeric structure of interconnected particles creating open cells comprises a carbon aerogel structure having a surface area in the range of between about 0.2 m<sup>2</sup>/gm and 3000 m<sup>2</sup>/gm.

15 37. The apparatus of Claim 31, wherein said molecular gas is taken from the group consisting of hydrogen and oxygen.

38. The apparatus of Claim 31, wherein said polymeric structure is taken from the group consisting of a catalyzed carbon aerogel monolith structures, metal oxide aerogels, ceramic aerogels, silica aerogels, and zeolites.

20 39. The apparatus of Claim 31, wherein said nanostructures comprise solid fibers or hollow tubes of carbon.

40. The apparatus of Claim 31, wherein said open cells range in size up to about 1000 Angstroms.

25 41. The apparatus of Claim 31, further comprising a catalyst disposed on said polymeric structure bonded to carboxyl sites disposed on said polymeric structure to form catalyst islands.

30 42. The method of Claim 41, wherein said deposited metal catalyst is taken from a group of transition metals consisting of Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn and combinations thereof.

43. The apparatus of Claim 41, wherein said deposited metal catalyst comprises an alloy of 70% Fe and 30% Cu.

44. The apparatus of Claim 41, wherein said nanostructures are configured to be 5 grown from said catalyst islands by preparing graphite nano-filaments by the decomposition of an effective amount of carbon-containing gas mixture precursors on said polymeric structure at an elevated temperature.

45. The apparatus of Claim 44, wherein said elevated temperature is in the range 10 of between about 500 °F and about 2000 °F.

46. The apparatus of Claim 44, wherein said carbon-containing gas mixture comprises gases taken from the group consisting of acetylene, benzene, carbon dioxide, carbon monoxide, hydrogen, and methane.

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47. The method of Claims 31, wherein said pressure vessel is configured to receive said molecular gas at a temperature of between about 77K and about 300K .

48. A method for forming a nanostructure laded reticulate structure for 20 sorption and desorption of molecular gas, comprising:  
polymerizing one or more precursor mixtures to form an aerogel;  
supercritically drying said aerogel to remove the liquid components and form a monolith aerogel;  
curing said monolith aerogel disposed and sealed into a mold;  
25 carbonizing said monolith aerogel by placing said carbonized aerogel in a reducing atmosphere at elevated temperatures;  
depositing a catalyst on the carbon aerogel which bonds to sites available on the aerogel to form catalyst islands;  
growing crystalline graphite precursors from said catalyst islands.

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49. The method of Claim 48, wherein said crystalline graphite precursors comprise platelet carbon nano-fibers, cylindrical carbon nanostructures, ribbon carbon nano-fibers, faceted tubular carbon nano-fibers and herringbone carbon nano-fibers.

50. The method of Claim 48 further comprising introducing a hydrogen gas molecule into a pressure vessel which includes the nanostructure laded reticulate structure at a substantially low temperature in the range of liquid nitrogen temperature and atmospheric pressure for sorption of the hydrogen gas molecule; and thereafter

5 allowing said low temperature to rise to an ambient temperature with the corresponding rise in pressure.

51. A method for forming a nanostructure laded reticulate structure for sorption and desorption of molecular gas, comprising:

10 combining the sol-gel polymerization of one or more precursor mixtures of organic aerogel precursors, solvent precursors, sol-gel catalyst precursors, metal cation salts and organic acid metal salts/polymer sol-gel of acetates, benzoates, carbonates, chlorides, epoxides, formates, hydroxides, isopropoxides, nitrates and oxalates of metal precursors;

15 casting said sol-gel mixtures into a retort;

curing said sol-gel mixtures;

supercritical drying extraction of liquid from the cured sol-gel mixtures;

reducing and carbonizing said cured sol-gel mixtures in a reducing atmosphere of hydrogen to produce a catalyzed carbon aerogel monolith structure; and

20 growing graphite nano-filaments on said reticulated catalyzed carbon aerogel monolith structures.

52. The method of Claim 51, wherein said growing graphite nano-filaments on said reticulated catalyzed carbon aerogel monolith structure comprises:

25 decomposing an effective amount carbon-containing gas mixed precursors on the catalyzed carbon aerogel structure at elevated temperatures.

53. The method of Claim 52, wherein said carbon-containing gas mixed precursors comprises at least one of acetylene, benzene, carbon dioxide, carbon

30 monoxide, hydrogen and methane.

54. The method of Claim 52, wherein said graphite nano-filaments comprises platelet nanostructure, cylindrical nanostructure, ribbon nanostructure, faceted tubular nanostructure and herringbone nanostructure.

55. The method of Claim 51, wherein said organic aerogel precursors comprise one of resorcinol-formaldehyde RF, phenolic-furfural PF, melamine-formaldehyde, phenolic-novolak resins GP®-2018C and FurCarb®UP520.

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56. The method of Claim 51, wherein said solvent precursors comprise at least one of acetic acid, acetone, butane, butyric acid, ethanol, ethyl ether, formic acid, hexane, isopentane, isopropanol, methanol, n-propanol, pentanoic acid, pentane, 1-propanol and propionic acid.

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57. The method of Claim 51, wherein said sol-gel catalyst precursors comprise at least one of sodium carbonate, hydrochloric acid, QUCORR®2001, toluenesulfonic acid, and phosphoric acid.

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58. The method of Claim 51, wherein said oxalates of metal precursors comprise at least one of chromium, cobalt, copper, iron, nickel and alloys of said metals.